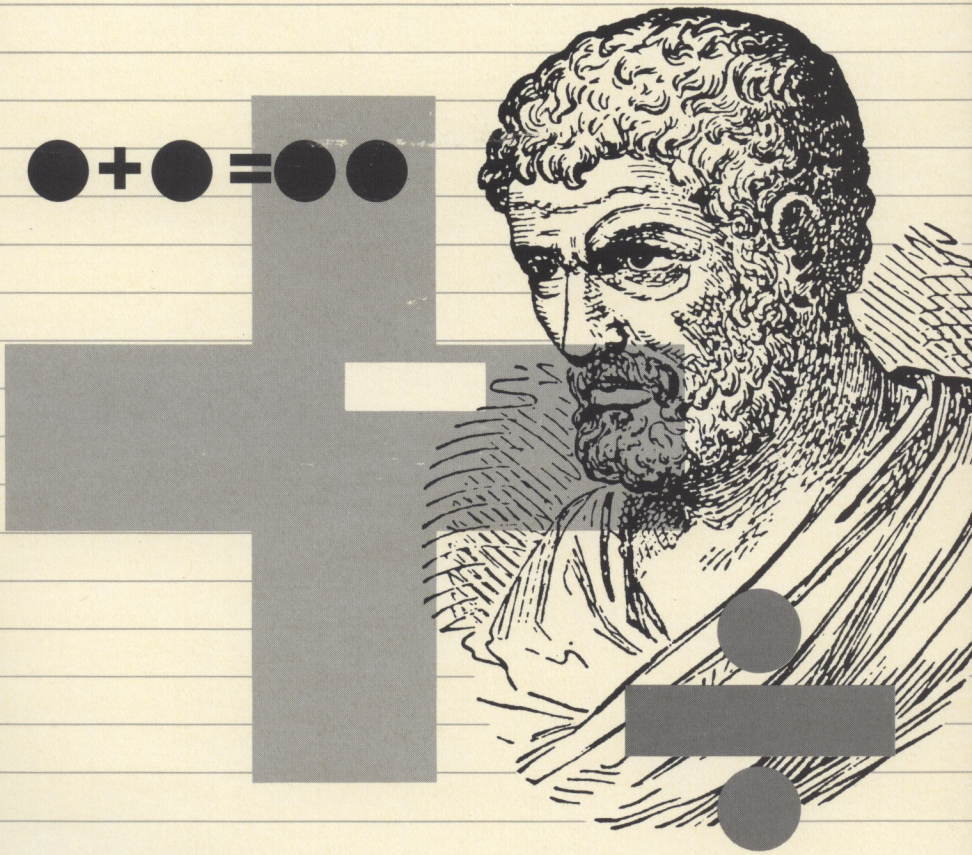
Metric and Problem Solving



ATARI®
LEARNING SYSTEMS

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Using This Program at Home

Many ATARI® Learning Systems program manuals were originally designed for use by teachers in the classroom. The programs themselves, however, are no less engaging and instructive for "independent learners" — children, students, and adults — working at home.

Every manual includes a "Getting Started" section that explains how to load the program into your computer system quickly and easily. Since many basic prompts and other instructions are displayed right on your screen, that's all you'll need to begin learning and exploring with most ATARI Learning Systems programs. But whether you're a parent, a tutor, or a home learner teaching yourself, it's a good idea to look through the teaching materials in your manual. You're likely to find important details on using the program, valuable supplemetary information on its subject matter, and some creative ideas for getting the most educational and entertainment value out of your ATARI Learning Systems program.

Introduction

The *Metric and Problem Solving* module, consisting of one diskette and this guide, has been designed for use with elementary grade levels two through six. The diskette will operate on any ATARI computer. This guide provides information essential for using the diskette effectively in a classroom setting.

The programs Metric Estimate, Metric Length, and Metric 21 provide drill and practice in working with metric units, estimation, and conversion. Bagels is a game of logic, and Hurkle is a game for teaching coordinate systems, direction, and point location. Number is a game of logic that uses varying ranges of numbers. Taxman teaches about factors of a number and prime numbers.

Handout pages in this booklet may be duplicated for use with students.

Index to Programs on Diskette

Bagels
A game of logic in which the student uses clues to guess a two-, three-, or four-digit number randomly selected by the computer

Hurkle
A game for learning to locate points on a number line or for teaching the coordinate system

Metric Estimate
A timed drill for estimating lengths of line segments in centimeters and millimeters

Metric Length
A drill on converting from one metric unit to another, using centimeters and millimeters

Metric 21
A game of blackjack for improving skill in approximating metric lengths

Number
A game of logic that can use various ranges of numbers — the computer chooses a number and gives clues

Taxman
A game that teaches about factors of a number and prime numbers

Follow these steps to load the Metric and Problem Solving program into your ATARI computer system:

1. With your computer turned off, turn on your television set or monitor and disk drive. Wait for the busy light on the disk drive to go out.

2. If your computer is *not* equipped with built-in ATARI BASIC, insert an ATARI BASIC cartridge in the cartridge slot (the left cartridge slot on the ATARI 800® computer).

3. Insert the Metric and Problem Solving diskette in your disk drive (disk drive 1, if you have more than one drive) and close the disk drive door or latch.

4. Turn on your computer. As your disk drive goes to work, you'll hear a beeping sound while the first part of the program loads into your computer. After several moments, a title screen will appear on your screen, followed by a menu of program selections.

Because your computer loads portions of the program as you use them, you must leave the Metric and Problem Solving diskette in your disk drive while using the program.

Some questions asked by the Metric and Problem Solving program require a simple Yes or No answer. You may respond by typing **YES** or **NO**, or simply by typing **Y** or **N**. Always press **RETURN** to confirm your response to a question. You may usually change your response before pressing **RETURN**; just use the **DELETE BACK SPACE** key to delete your original response, then type in the new response.

To return to the program menu, hold down the **ESC** key. When the question Do you want to try again? appears, type **N** and press **RETURN**.

For access to any teacher options in the program, press **CTRL** and **A** simultaneously.

Bagels

A Guessing Game with Numbers

Specific Topic:	Logic, place values
Type:	Educational game
Reading Level:	2.6 (Spache)
Grade Level:	3–6

Description

Bagels is a number game in which the computer randomly generates a two-, three-, or four-digit number. The student guesses a number, and the computer gives clues as to whether any digits in the guess are in the secret number. The clues are given in the form of three words:

PICO means one digit is correct but in the wrong place.

FERMI means one digit is correct and in the right place.

BAGELS means none of the digits is correct.

Bagels

Objectives

- To improve the ability to reason and make logical guesses
- To acquire a better understanding of place value
- To discover an optimum strategy for guessing the number in the fewest tries
- To draw conclusions by using reasoning of some of the following kinds:
  - cause-effect relationships
  - use of proof by exhaustion of possibilities
  - induction
  - deduction

Bagels

Background Information

Bagels is an educational game providing students with practice in using logic and place value. The computer chooses numbers at random, making every run of the game different. The computer never uses the same digit twice; for example, it would not pick a number like *223*. As the students play the game, they must use logic to put clues together and discover the number.

If the computer generates the number *123*, and the student guesses *456*, the computer will give the clue **BAGELS** because none of the digits is correct.

If the student guesses *145*, the computer will print **FERMI** because the 1 is in the correct place.

If the student guesses *245*, the computer will print **PICO** because the 2 is correct but in the wrong place.

If the student guesses *142*, the computer will print **FERMI PICO** because 1 is the correct digit in the correct place, and 2 is the correct digit but in the wrong place.

Bagels

Use in an Instructional Setting

Preparation

Before the students play Bagels individually on the computer, the class might play a few rounds "by hand," with the teacher thinking of a two-digit number. This will make students aware of the type of logical thinking involved. Demonstrating the program to the whole class, with the class jointly deciding on each next guess, is also an effective way to introduce Bagels.

As students play Bagels with the computer, you may wish to select the number of digits. The more digits selected, the more difficult the game.

Using the Program

To discover an optimum strategy for guessing the number in the fewest tries, students could use Handout 1, Bagels. If all guesses are recorded, the students can study the pattern and try to develop a strategy for increasing their speed in guessing the correct number. The number should not repeat any digit; zero can be used.

You can use the program in the following ways:

- As an independent activity to develop logic and strategy (students use Handout 1, Bagels, to record their guesses and the computer responses)
- As a method to motivate students to use logic and strategy by playing a competitive game (students use Handout 1, Bagels to create a game in which they have an opponent)
- As an entire class or group activity — divide the group in half and see which group guesses the number in the fewest tries
- As a record of improvement in use of logic, understanding of place value, and strategy (using Handout 2, Bagels)

Follow-up

Here are two activities for students who would like to pursue practice in logic and strategy:

- Without the aid of the computer, use a four-digit numeral to play the game.
- Play the game using the letters of the alphabet instead of numbers. Discuss why this game is more difficult than the number game.

Bagels

Name _____

Class _____ Date _____

BAGELS - No digits correct

PICO - One digit correct — wrong place

FERMI - One digit correct — right place

My number is: _____

Number of digits: _____

Opponent's Guesses Digits			Responses			My Guesses Digits			Responses		
1st	2nd	3rd	PICO	FERMI	BAGELS	1st	2nd	3rd	PICO	FERMI	BAGELS

Possible Digits 0 1 2 3 4 5 6 7 8 9

Bagels

Name _____

Class _____ Date _____

BAGELS - No digits correct

PICO - One digit correct — wrong place

FERMI — One digit correct — right place

The number was _____ The number was _____

It took me _____ guesses It took me _____ guesses

The number was _____ The number was _____

It took me _____ guesses It took me _____ guesses

The number was _____ The number was _____

It took me _____ guesses It took me _____ guesses

The number was _____ The number was _____

It took me _____ guesses It took me _____ guesses

Bagels

Sample Runs

```
The computer will think of a
number and you will try and
guess what the number is.
You will have 18 tries to
attempt to guess it.

How many digits do you want
in the number?  (2-4 only)
```

Players decide how many digits the number will contain, then the computer "thinks" of a number and asks players to guess what it is.

```
The computer has a 3 digit number
---------------------------------
    GUESS   CLUE
1)  ?123    FERMI
2)  ?456    BAGELS
3)  ?789    FERMI
4)  ?145    BAGELS
5)  ?425    FERMI
6)  ?

(To see answer, enter all zeroes)
```

Players have up to 18 tries to guess the correct number. They can see the correct number at any time by typing zeroes.

Examples of Screen Output

Hurkle

Learning to Locate Points

Specific Topic:	Locating points, graphing, number line
Type:	Educational game
Reading Level:	2.2 (Spache)
Grade Level:	2–6

Description

The Hurkle, an imaginary creature, hides on a grid or number line. Students find it with the aid of computer clues in the form of directions such as south or northeast. Students work with a vertical number line, a horizontal number line, a 10×10 grid, or a $-5 \times +5$ grid.

Objectives

- To locate points on a horizontal line, vertical line, positive coordinate system (0 to 10), or coordinate grid from -5 to $+5$
- To reinforce concepts of direction
- To recognize when one or more particular strategies are appropriate

Hurkle

Background Information

Hurkle was developed to help students learn the concept of direction and use strategy to locate the Hurkle on a grid or number line.

What is a Hurkle? A Hurkle is a happy beast that lives in another galaxy on a planet named Lirth, which has three moons. Hurkles are favorite pets of the Gwik, the dominant race of Lirth, and...

To find out more, read "The Hurkle Is a Happy Beast" in *A Way Home* by Theodore Sturgeon.

In each option the Hurkle hides on a point that students try to locate, and the computer gives clues by describing in which direction the user should move: north, south, east, or west. The object is to find the Hurkle in the fewest guesses.

Hurkle has four options:

1. A horizontal line
2. A vertical line
3. A 10×10 grid
4. A $-5 \times +5$ grid

When using one of the grids, students should discover where a good first guess might lie (near the center of a 10×10 or the origin of -5×5). What is the minimum number of guesses needed to locate Hurkle if one uses the optimal strategy? Is it harder to find Hurkle on the grid than on the straight line? Why?

Students should be allowed and encouraged to discover for themselves that when the Hurkle is on a single line, a good first guess is at the middle of the line — not at one end. Some students might be able to figure out through experience the minimum number of guesses it will take to find the Hurkle by considering all possible situations.

Options 3 and 4 are designed to enable the student to *discover* the concept of ordered pairs of numbers as the label of a point on coordinate axes. Most students have difficulty understanding and remembering that the horizontal value x is listed first, then the vertical value y. By entering an ordered pair (for example 1,4) and observing the corresponding point that appears on the grid, the students learn through their own experience which number is the x value and which is the y value.

Expect mistakes at first — mistakes are an important part of this learning process. The students will say, "But I wanted the point over *there*. Why did it show up here?" They will then realize that they entered the numbers in reverse order.

Use in an Instructional Setting

Preparation

To effectively use Hurkle to reinforce direction and strategy, it will be necessary for the student to be familiar with direction (north/south/east/west) as well as with horizontal, vertical, and a grid. To use option 4, it's also necessary to know about a $-5 \times +5$ grid. It's suggested that a student begin with option 1 and move on to options 2, 3, and 4, when ready.

Options 3 and 4 are not recommended for use with primary students because they involve the use of a coordinate system.

You may wish to adjust the volume on the television or monitor so that the sound doesn't disturb the class. For option 4, -5×5 grid, students will need to use the minus ($-$) key, which is 2 keys left of **RETURN** on the ATARI computer.

Using the Program

You can use the program in the following ways:

• Have a student try to locate the Hurkle in a minimum number of tries. Plan for effective strategy to locate the Hurkle.

• Have the students work in small groups, trying to find the Hurkle in the fewest tries.

As a group, discuss finding effective strategy to locate the Hurkle.

• When introducing the coordinate system, have students use option 3. Using Handout 3, Hurkle, have students select a point, plot it on the handout, and then enter it into the computer. Have students check to see if the point they plotted on their worksheets is the same on the computer graph. This will give students a chance to check their work against the computer.

• Play option 4 of Hurkle. (This may be too advanced for grades lower than sixth.) This option could be used by a few students to play on their own, or it could be used in the class in the same way as option 3. Use Handout 4, Hurkle with option 4.

Follow-up

The following activities are designed to assist students in using logic, direction and strategy:

- Have students use Handout 3, Hurkle, and Handout 4, Hurkle, to check their work against the computer and study ways to improve their logic and strategy.

- Have primary students draw a picture of how they imagine a Hurkle would look.

- Introduce the fantasy of the Hurkle (see Background Information) and have students write a description of the Hurkle or write a Hurkle adventure story.

• Working in small groups, have students use a map and practice moving a toy car in specific directions, such as southeast or north.

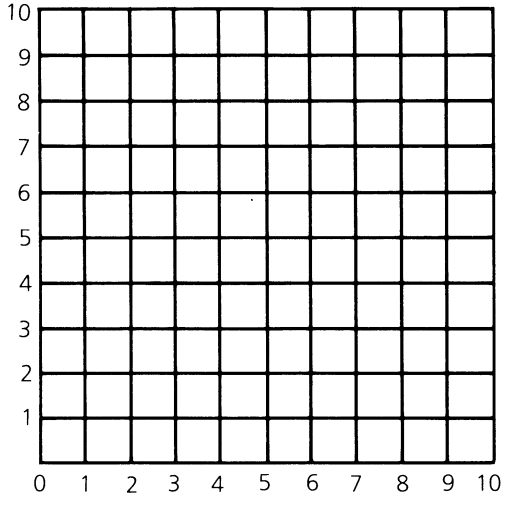
• List and discuss other games the students have played that involve strategy (for example, checkers, chess, Othello, Bagels). How does one discover a good strategy? Could there be more than one good strategy for a given game?

• List and discuss instances in which a coordinate system (grid) is used — for example, the game Battleship, a street system, some tables/charts, or a multiplication table.

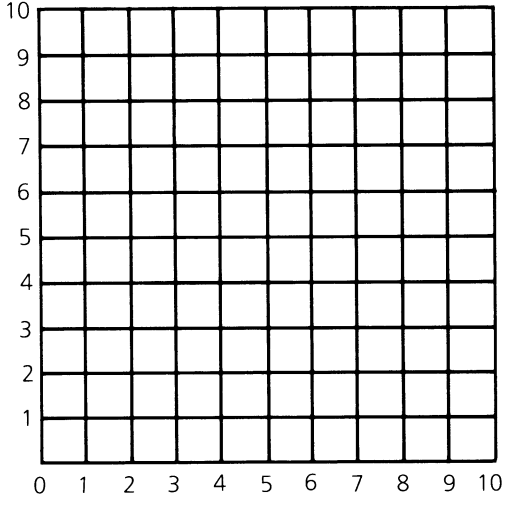
Hurkle

Name _____

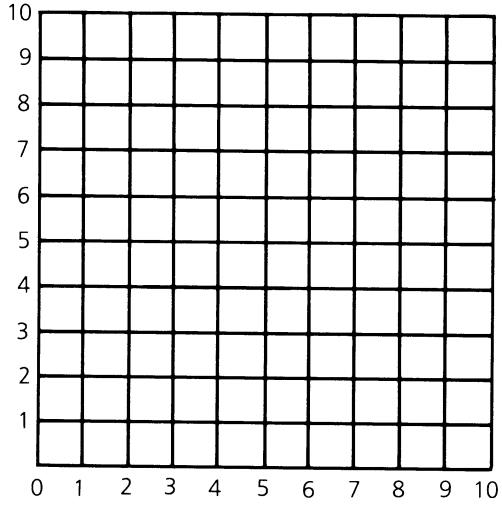
Class _____ Date _____



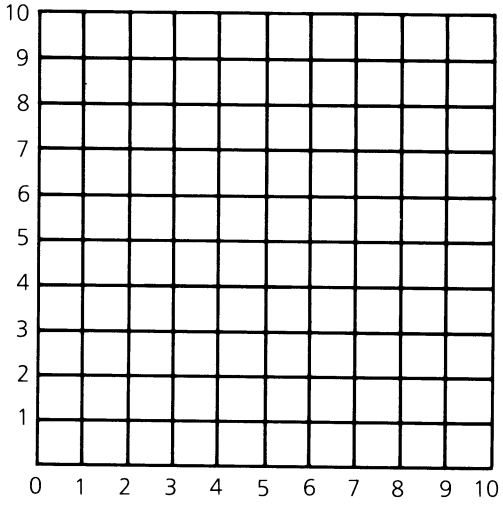
I found the Hurkle in _____ tries.
I didn't find the Hurkle. _____



I found the Hurkle in _____ tries.
I didn't find the Hurkle. _____



I found the Hurkle in _____ tries.
I didn't find the Hurkle. _____

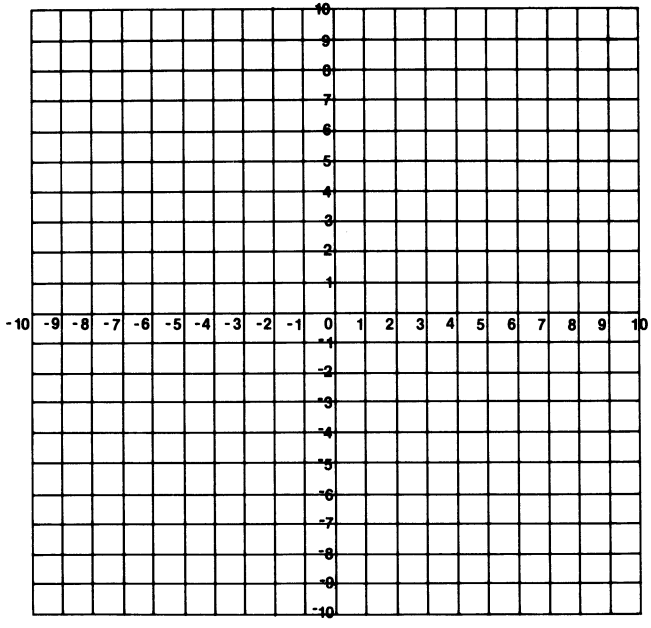


I found the Hurkle in _____ tries.
I didn't find the Hurkle. _____

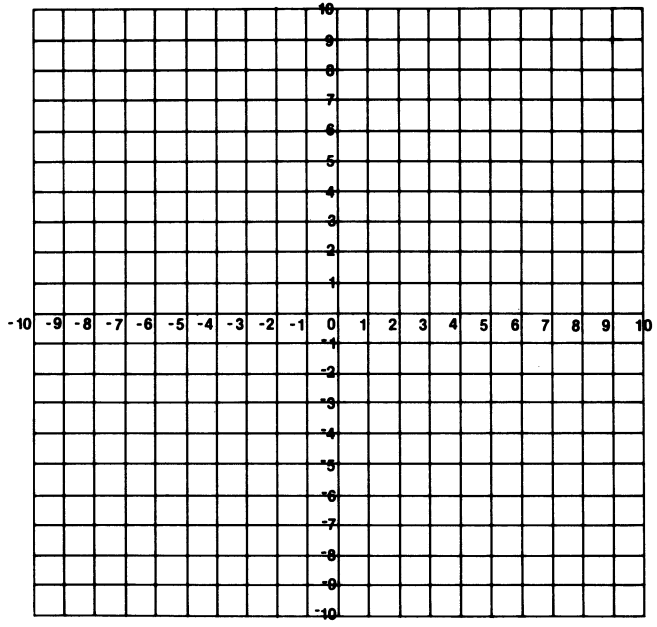
Hurkle

Name _____

Class _____ Date _____

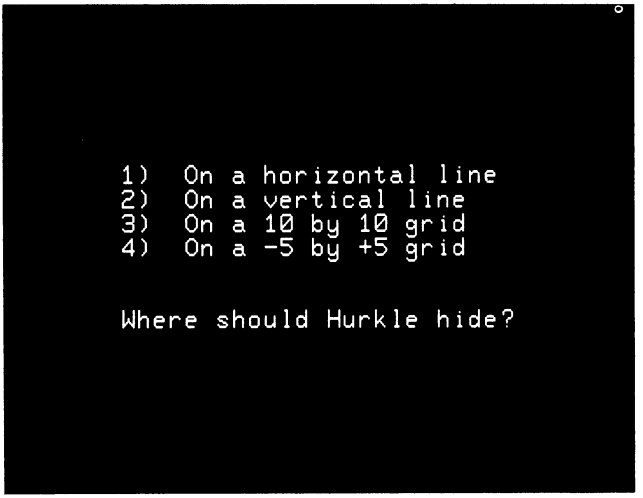


I found the Hurkle in _____ tries.
I didn't find the Hurkle. _____

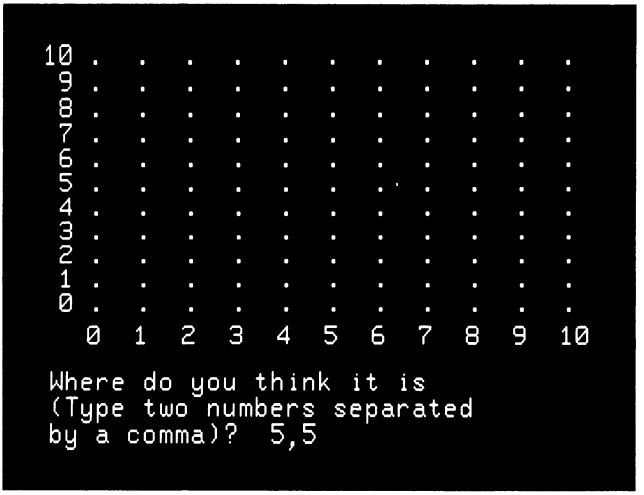


I found the Hurkle
in _____ tries.
I didn't find
the Hurkle. _____

Sample Runs



There are four options for finding the Hurkle, ranging from relatively easy to difficult. The teacher may specify the option or let students choose.



The computer gives directional clues for locating the Hurkle's hiding place. (In options 3 and 4, students respond by typing in two numbers separated by a comma.) The computer will tell how many turns it took to find the Hurkle, or whether it took too many turns.

Examples of Screen Output

Metric Estimate

Estimating Metric Lengths

Specific Topic:	Measurement estimation
Type:	Drill and practice
Reading Level:	3.8 (Spache)
Grade Level:	4–6

Description

Students are shown a line segment and are asked to estimate its length in centimeters or millimeters.

Objectives

- To use metric measures as units of length
- To estimate the length of a segment to the nearest centimeter or millimeter
- To select and use appropriate units to measure length
- To determine whether or not a proposed answer is reasonable
- To use metric prefixes

Metric Estimate

Background Information

The Metric Estimate program provides practice in estimating lengths in centimeters or millimeters. Because of the varying sizes of television screens, it's essential that a sample line segment be measured before the students use the program. At the beginning of the first run, the computer asks that two lines be measured and that their values be entered in millimeters. *The answer must be in millimeters.* Once the two line lengths are measured, the measurements should be filled in on the top section of Handout 5, Metric Estimate. It's not necessary for each student to repeat this procedure.

When working at the computer, students can answer in either centimeters or millimeters, though centimeters will be easier for most students. If the student is working with millimeters, estimates within one millimeter will be considered correct. If the answer is within a close range (8 millimeters, 2.2 centimeters) the message "Close" is printed. The true value is given and another line segment is generated.

Metric Estimate

Use in an Instructional Setting

Preparation

Introduce the concept of centimeters and millimeters. Have students use a metric ruler to measure familiar items — this will acquaint them with the length of a centimeter and millimeter. Have them check one another's work.

Using the Program

Have students use the program Metric Estimate individually, and record results on the handout.

Hold a metric-by-computer contest, with individual students or small groups running the program. Handout 5, Metric Estimate, can be used by each team for record keeping. Teams may earn two points for a correct answer on the first try and one point for a correct answer on the second try. The team with the most points wins.

Follow-up

Students interested in improving their abilities in metric estimating could continue to estimate objects in their environment in metric units.

Once students have an idea of the length of a centimeter, organize a scavenger hunt. Give students a list of various lengths in centimeters, and have them find objects that match the given lengths. The first group or individual to complete the activity is the winner.

Metric Estimate

Name _____

Class _____ Date _____

Measurement 1	
Measurement 2	
Number of problems	
Measure in centimeters	
Measure in millimeters	

____ Number tried
____ Number correct first try
____ Number correct second try

____ Number tried
____ Number correct first try
____ Number correct second try

____ Number tried
____ Number correct first try
____ Number correct second try

____ Number tried
____ Number correct first try
____ Number correct second try

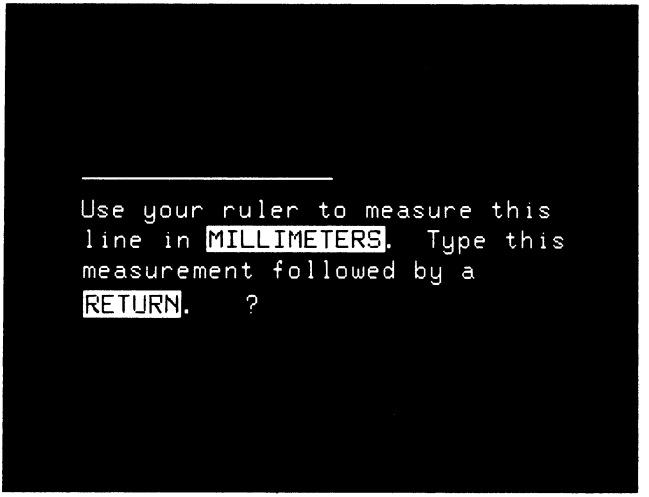
____ Number tried
____ Number correct first try
____ Number correct second try

____ Number tried
____ Number correct first try
____ Number correct second try

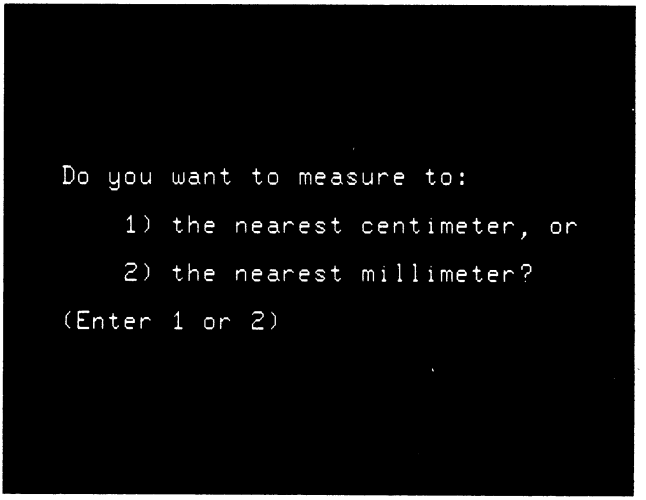
Metric Estimate

Sample Runs

After printing instructions, the computer will direct the student to adjust measurements for the individual television screen size by typing in the length of the line displayed in millimeters.



Students may choose between measuring in centimeters or in millimeters by entering a 1 or 2. Answers in millimeters will be given in whole numbers. Answers in centimeters may be given in decimals.



Examples of Screen Output

Metric Length

Working with Metric Units

Specific Topic:	Metric length, measurement
Type:	Drill and practice
Reading Level:	3.4 (Spache)
Grade Level:	4–6

Description

This program gives a student practice in converting units within the metric system, using millimeters, centimeters, meters, and kilometers.

Objectives

- To practice converting within the metric system
- To reinforce the meanings of the prefixes milli, centi, and kilo
- To use metric prefixes

Metric Length

Background Information

The Metric Length program includes conversions from the most common units — millimeters, centimeters, meters, and kilometers. Here's a conversion chart:

10 millimeters (mm) = 1 centimeter (cm)

100 centimeters (cm) = 1 meter (m)

1000 meters (m) = 1 kilometer (km)

Students choose the number of problems they want to work on, and they have two chances to answer each problem correctly. A summary score is provided at the end.

This is a drill in converting from one unit of metric length to another. The units used will include the millimeter (mm), centimeter (cm), meter (m), and kilometer (km). The student is given a length in one unit and is asked to convert it to another unit.

Metric Length

Use in an Instructional Setting

Preparation

Students need to be familiar with the different units of metric measurement and to understand how to convert from one unit to another. The program works with conversions from the most common units — millimeters, centimeters, meters, and kilometers.

Using the Program

Students may use this program individually, or they can work in pairs. Have them use Handout 6, Metric Length to record their scores.

Follow-up

Students can use Handout 6, Metric Length to keep a record of their progress.

Have students measure items found in their environment, measuring in one unit (cm) and converting to another (mm).

Students can list objects that are best measured by millimeters, centimeters, meters, or kilometers.

Metric Length

Name _____

Class _____ Date _____

Number of problems: ____

____ Number tried
____ Number correct first try
____ Number correct second try

____ Number tried
____ Number correct first try
____ Number correct second try

____ Number tried
____ Number correct first try
____ Number correct second try

____ Number tried
____ Number correct first try
____ Number correct second try

____ Number tried
____ Number correct first try
____ Number correct second try

____ Number tried
____ Number correct first try
____ Number correct second try

Metric Length

Sample Runs

```
                PROBLEM #2
                ----------

176 mm = 1760    cm
  That's not right...Try again!

176 mm = 17.6    cm
Right on!


     Press RETURN to continue.
```

Students convert from one metric unit to another and are given two tries to get the correct answer.

```
**************************
*                        *
*  Number tried ...10    *
*                        *
*                        *
*  Number correct        *
*                        *
*   First try.......7    *
*                        *
*   Second try......2    *
*                        *
**************************
```

After problems are completed, the computer shows the number of problems tried and the number correct on each try.

Examples of Screen Output

Metric 21

Approximating Line Lengths

Specific Topic:	Metric measurement
Type:	Educational game, drill and practice
Reading Level:	3.6 (Spache)
Grade Level:	4–6

Description

Students play a game of metric blackjack with the computer. Line segments 1 to 10 centimeters long are given. Using their knowledge of the metric system, students determine when their line segments add up to 21 centimeters.

Objectives

- To approximate the length of a segment from 1 to 10 centimeters
- To practice metric approximation in a game format
- To practice addition of whole numbers whose sum is normally less than 21
- To use metric prefixes

Metric 21

Background Information

Metric 21 is a game of metric blackjack. It's like the card game of blackjack or 21. The object is to get lines that add up to 21 centimeters but don't go over.

Each player is given two lengths. The computer is the dealer and takes two lengths. Players see only the computer's first length until all of them have finished.

The game begins with the first player, who should look at his or her two line segments and determine whether they total close to but not over 21 centimeters. A player may request a maximum of five line segments. Each player goes through the same procedure.

The computer will then show its second length. The computer continues to take lengths until the total is between 17 and 21 centimeters.

If the computer's total goes over 21 centimeters, the players who have not gone over 21 win. If the computer wins, it gets two points and the player gets -1. If there's a tie, the computer gets one and the players get zero. If the computer loses, the player gets one and the computer gets -2.

The process is the same whether there are 1, 2, or 3 players.

Use in an Instructional Setting

Preparation

Students need to understand the game of blackjack. The object is to get line segments to add up to exactly 21 centimeters.

In order to adjust the line segments to different televisions, the computer will always ask the length of a line segment at the beginning of the game. If the student or teacher measures the line segment once on the television used in the classroom and records it on the worksheet, the students won't have to measure the line each time that television is used.

Using the Program

Have students divide into groups of two or three and play Metric 21 with the computer. Use Handout 7, Metric 21, for record keeping.

The program can be used in the following ways:

- As an independent activity to develop the skill of identifying the approximate length of a segment from 1 to 10 centimeters
- To develop skill in adding to 21
- To develop game strategy on how close one can come to 21 without going over

Follow-up

Discuss with the class the strategies that students have developed for playing Metric 21.

Discuss with the class the pros and cons of the use of metric measurement.

Divide the students into teams, and run a tournament with Metric 21.

Metric 21

Name _____

Class _____ Date _____

Measurement: _____ cm

Number of games played: _____

Player #1 _____ : Score _____

Player #2 _____ : Score _____

Player #3 _____ : Score _____

Computer: Score _____

Number of games played: _____

Player #1 _____ : Score _____

Player #2 _____ : Score _____

Player #3 _____ : Score _____

Computer: Score _____

Number of games played: _____

Player #1 _____ : Score _____

Player #2 _____ : Score _____

Player #3 _____ : Score _____

Computer: Score _____

Number of games played: _____

Player #1 _____ : Score _____

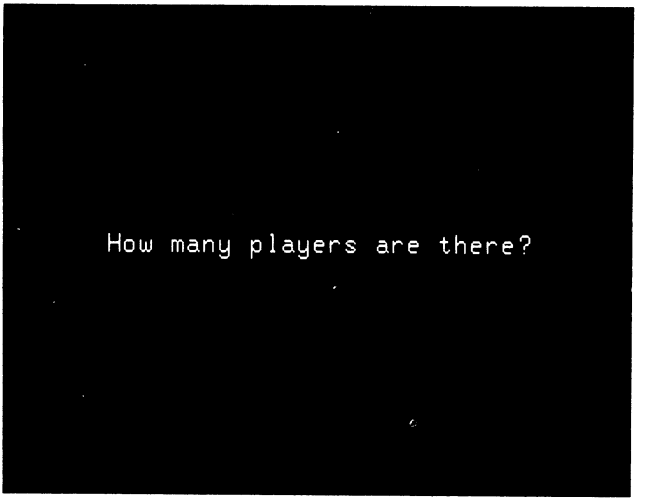
Player #2 _____ : Score _____

Player #3 _____ : Score _____

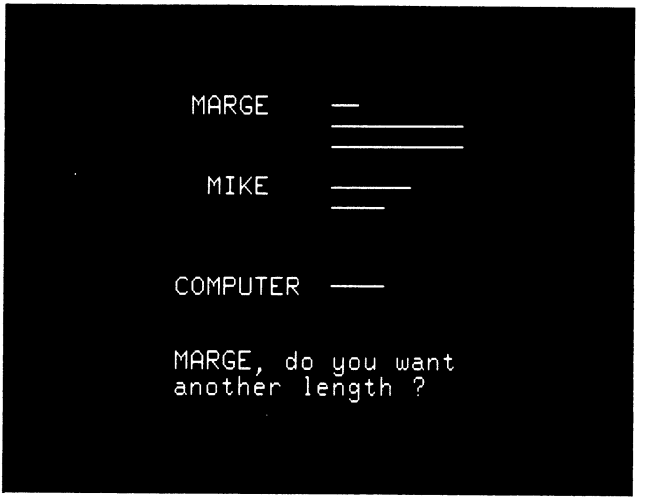
Computer: Score _____

Metric 21

Sample Runs



The computer asks the player to measure the line on the display in centimeters. It will then give instructions and ask for the number of players.



Players try to reach 21 centimeters with five or fewer lengths.

Examples of Screen Output

Guessing by Logic

Specific Topic:	Ordering numbers
Type:	Educational game
Reading Level:	1.9 (Spache)
Grade Level:	1–5

Description

Students try to guess the number that the computer has chosen. The computer gives clues — either "too big" or "too small." You can adapt the program for different grade levels by specifying the range of numbers from which the computer makes its selection.

Objectives

- To practice ordering numbers
- To develop strategies for guessing a number
- To use appropriate strategies in solving mathematics problems

Background Information

The computer randomly selects a number between one and a limit set by the student. If students are studying the order of numbers 1 through 10, the limit would be 10. The number chosen can be any number less than 99999. The students must try to guess the number the computer has chosen. The computer gives clues of "too big" or "too small." By using logic, the students should be able to find the number.

If the students choose a range of numbers below 13, the computer will represent the numbers graphically on a number line as a help to younger students in learning the order of numbers.

An effective strategy is to select a number halfway between one and the largest number. Students should continue selecting on that principle, using the clues "too big" or "too small" until they get the correct number.

Use in an Instructional Setting

Preparation

Play the Number game with the class without the use of the computer. Have one student write a number between 1 and 100 (or 1 and 10, for younger students) on a sheet of paper and keep it secret. Have other students guess a number. Give clues by saying "too big" or "too small." Students can record their guesses and clues at their desks, or one student can write them on the chalkboard. Example:

Number on paper	Guess	Clue
8	25	too big
	13	too big
	6	too small
	8	That's it!

Using the Program

This program can be used in the following ways:

- Have a student try to guess the number in as few tries as possible. Encourage students to discover an effective strategy for guessing the number.

- Have students work in small groups, trying to guess the number in the fewest tries. The groups can discuss effective strategies for finding the correct number, and report the strategies to the class.

- Divide the class into groups of three or four. Each group goes to the computer and runs Number six to ten times. Record the smallest and largest number of guesses required.

- If working with older students, average the number of guesses for their group. The group with the lowest average is the winner. Discuss the strategy that worked best. Use Handout 8, Number, for record keeping.

Follow-up

The following activities are designed to assist students in using logic, direction, and strategy.

Have students play a game in which they guess a number by asking questions that can be answered by yes or no — for example, "Is it greater than 50?"

Have students play a similar game with the alphabet. Each time, answer that the letter is closer to or farther from A.

Discuss which game is easier, the one with numbers or the one with letters.

Number

Name _____

Class _____ Date _____

_____ Largest number	_____ Largest number
_____ Number of guesses	_____ Number of guesses
_____ Largest number	_____ Largest number
_____ Number of guesses	_____ Number of guesses
_____ Largest number	_____ Largest number
_____ Number of guesses	_____ Number of guesses
_____ Largest number	_____ Average number
_____ Number of guesses	of guesses

_____ Largest number

_____ Number of guesses

_____ Largest number

_____ Number of guesses

_____ Largest number

_____ Number of guesses

_____ Largest number

_____ Number of guesses

_____ Largest number

_____ Number of guesses

_____ Largest number

_____ Number of guesses

_____ Largest number

_____ Number of guesses

_____ Average number of guesses

Sample Runs

After giving the students instructions, the computer will randomly choose a number between 1 and the upper limit set. This limit can be no larger than 99999. (Don't use commas when entering numerical data.) Start with a lower limit like 10 or 100 until students understand the game; then adjust the limit.

```
What is the largest number
that you want ?
```

```
OK, try to guess the number.
    Guess #  1?500    too big.
    Guess #  2?80     too small.
    Guess #  3?
```

The student guesses a number — for example "80" — and the computer responds with "too big," "too small," or "you guessed it."

Examples of Screen Output

Taxman

Studying Factors of Numbers

Specific Topic:	Primes, composites, and factors
Type:	Educational game
Reading Level:	3.3 (Spache)
Grade Level:	5–6

Description

Taxman provides practice in factoring of a number and in recognizing prime numbers. Students choose a number from a list, and the "taxman" gets all the factors of that number that remain in the list. The students compete with the taxman for the high score. These numbers are deleted from the list, and the new list is displayed. The user must again choose a number that has factors, and the taxman gets any factors. This continues until no factors are left.

Taxman

Objectives

- To discover factoring properties of composites and distinguish between primes and composites
- To develop different strategies for use with Taxman
- To analyze the results of strategies to learn why some work and others fail
- To recognize when one or more particular strategies are appropriate
- To use reason to draw conclusions

Taxman

Background Information

Taxman is an educational game designed to give the student practice in factoring numbers and recognizing prime numbers. It's necessary for the student to be familiar with factor properties of composites and to be able to distinguish between primes and composites.

The rules for Taxman should be viewed at the beginning of play. The game starts when the player chooses the upper maximum of a list of sequential numbers (range 2 through 50). The first time students use the program, they should use numbers from 1 through 10. The computer will display the number list on the screen as follows:

1 2 3 4 5 6 7 8 9 10

The player takes a number, and the computer (taxman) takes all the factors of the number — that is all the numbers that divide evenly into the selected number. For example, if a player chooses 8, the computer will take 4, 2, and 1. This gives the player 8 points and the computer 4 + 2 + 1, or 7 points. If the player chooses 9, on the first play the computer will take 3 and 1, giving the player 9 points and the computer 3 + 1, or 4 points.

The numbers taken by the player and the computer are then removed from the list. Players cannot take a number unless there are some factors on the list for the taxman. When no factors are left, Taxman gets all the remaining numbers.

Students should develop their own strategies for playing the game. A typical game is as follows:

Move 1:
1 2 3 4 5 6 7 8 9 10
(A good first move is to take the largest prime number on the list. One is a factor of all numbers, and by taking the largest prime, the player gets a large number, while the computer gets only one.)

Player takes 7
Computer takes 1

Move 2:
New List
2 3 4 5 6 8 9 10
(The player tries to take numbers that have only one factor on the list. Nine is a good choice.)

Player takes 9	Total: 9 + 7 = 16
Computer takes 3	Total: 3 + 1 = 4

Move 3:
New List
2 4 5 6 8 10
(If a player takes 8, 2 and 4 are lost. If a player takes 10, 2 and 5 are lost. But if a player takes 6, only 2 is lost, and 8 and 10 can still be taken.)

Player takes 6	Total: 6 + 16 = 22
Computer takes 2	Total: 2 + 4 = 6

Move 4:
New List
4 5 8 10

Player takes 10	Total: 22 + 10 = 32
Computer takes 5	Total: 6 + 5 = 11

Move 5:
New List
4 8

Player takes 8	Total: 40
Computer takes 4	Total: 15

Use in an Instructional Setting

Preparation

To use Taxman effectively, students need to understand the rules of the game and to understand primes, composites, and factors.

It's recommended that you give a classroom demonstration before students use the program alone or in pairs. Remind students that the more numbers they select, the more difficult the program.

Using the Program

The program can be used in these ways following the study of factors of a number.

- Play the game with the computer a few times, with the entire class participating. Keep a scoresheet on an overhead or the chalkboard. Use these records to study strategy and analyze results.

- Play the game as an individual activity to develop skill in understanding primes and factors, and to devise a strategy to win.

- As a group activity, have groups of students confer to discuss strategies and to see if a method could be generalized.
- Use Handout 9, Taxman, to record your scores and the computer's score.
- Students can keep a written record of their selections and what the computer (taxman) takes. They should study these to develop a greater understanding of prime numbers and factors.
- Have students work in pairs to develop strategy to beat the taxman.

Follow-up

Have students list the prime numbers below 50 or 100.

Have students research the sieve of Eratosthenes (a method for determining prime numbers).

Taxman

Name _____

Class _____ Date _____

My number list was to _____

Taxman score ____

My score ____

My number list was to _____

Taxman score ____

My score ____

My number list was to _____

Taxman score ____

My score ____

My number list was to _____

Taxman score ____

My score ____

My number list was to _____

Taxman score ____

My score ____

My number list was to _____

Taxman score ____

My score ____

My number list was to _____

Taxman score ____

My score ____

My number list was to _____

Taxman score ____

My score ____

My number list was to _____

Taxman score ____

My score ____

My number list was to _____

Taxman score ____

My score ____

Sample Runs

```
How many numbers do you want in
the list?
```

After displaying the instructions, the computer asks how many numbers students want in the list. The longer the list, the more difficult the game.

```
Your total: 7   Taxman's total: 1
New list:
  1   2   3   4   5   6   7

You take?  7
Taxman gets  1

    Press RETURN to continue.
```

An example of a list of numbers from 1 through 7 is displayed on the screen. If the players choose 7, the Taxman gets 1 and the new list will be 2 3 4 5 6.

Examples of Screen Output

The ATARI Learning Systems Metric and Problem Solving program was originally developed by the Minnesota Educational Computing Consortium (MECC). Support material was prepared by Doris Bower, MECC.

Bagels, a commonly used computer program, originated with PEOPLE's Computer Company in Menlo Park, California. The MECC version was modified to work with 2- 3- or 4-digit numbers by Bob Jamison. The ATARI version was converted by Don Rawitsch.

The original version of Hurkle was developed by PEOPLE's Computer Company. MECC staff modified Hurkle to work with a horizontal line, vertical line, or -5 × +5 grid and then added graphics by Mike Stein and Kent Kehrberg. The ATARI version was done by Lance Allred.

The original author of Metric Estimate, then called Estmat, was Don Holznagel, formerly of T.I.E.S. MECC revised the program to be screen-oriented and included the options of millimeters or centimeters. The conversion to the ATARI was completed by Cynthia Schroeder.

The Metric Length program was created by Bob Jamison, formerly of the MECC staff. The conversion to the ATARI was completed by Lance Allred.

The original Metric 21 was done by David Dye, Mathematics Consultant for the Minnesota State Department of Education. The program was modified by MECC staff, and the ATARI conversion was done by Tony Prokott.

The Number program originated with PEOPLE's Computer Company of Menlo Park, California. That version was modified by Rick Crist, MECC staff, to include a range of numbers and a graphic option for numbers under 15. The ATARI conversion was done by John Brisky.

The Taxman program was introduced to the MECC collection of software from the former Southern Minnesota Schools Computer Project. Documentation first appeared in publications by PEOPLE's Computer Company. Conversion to the ATARI was done by Charles Erickson.

The content of this support booklet is in large part a revision of material written by Shirley Keran, MECC, which in turn included much material from the book *Elementary, My Dear Computer* developed by Marge Kosel and Geraldine Carlstrom for Timeshare Computing. Teachers from throughout the state of Minnesota contributed ideas to that effort.

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